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Paper on Use of W.S.P. in Montana Fish and Game Department Fishery Studies

Introduction

The Bureau of Reclamation became involved with the Montana Fish & Game application of our Water Surface Profile (W.S.P.) Program through our Technical Assistance Program. The Technical Assistance Program is a cooperative venture between the State of Montana and the Department of Interior. Mr. John Keys of the Bureau of Reclamation is the Department of Interior's contact. The Technical Assistance Program allows the Bureau ~~of~~ to share its technical expertise and computer capability with a State agency when the need arises. In late 1973 and early 1974 final arrangements for this technical help were made.

The Montana State Fish and Game Department is attempting to identify critical stream areas and sections. Information is needed to determine a stream maintenance flow and establish a water right to insure this flow's availability. Data needed to find what the stream maintenance flow is include flow velocities, flow quantities, water depths, water surface elevations, and cross-sectional areas. These data can be determined through actual field measurements at many flows or can be computed using the W.S.P. computer program and one set of field measurements.

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for Mont. Fish & Game Dept use

This program was first applied on the Tongue River. Al Elser of the Montana Fish and Game Department Miles City District Office collected the necessary field data. These data were processed and run through W.S.P. with satisfactory results. Since that time the following stream sections have been analyzed using this method:

Location	Representative
Yellowstone River near Forsyth	Al Elser, MF&G
Yellowstone River near Shields River	Dennis Workman, MF&G
Tom Miner Creek	" " "
Rock Creek	" " "
Fridley Creek	" " "
Trail Creek	" " "
Sixteen Mile Creek	" " "
Tongue River near Dayton, Wyoming	Bill Jones, U.S.F.W.
Tongue River near Acme, Wyoming	" " "
Tongue River at Foss Ranch nr. Montana and Wyoming Line	" " "

Field data from other stream locations in Montana are currently being readied for application of W.S.P.

Description of W.S.P. Program

W.S.P. is a computer adaptation of the Bureau of Reclamation's Water Surface Profile Computation Method B. ~~The Water Surface Profile~~

~~Computation Method B.~~ The Water Surface Profile program was written to computerize computations necessary to determine tailwater and backwater elevations. These are the water surface elevations below dams and control structures and above reservoirs. The hand calculations needed to compute these elevations are very tedious.

W.S.P. is adaptable to instream applications. The program allows the users, after sufficient field work, to predict and/or study various changes in stream characteristics at many different flows. The predicted values are within the accuracy of the field data (see below). The program (model) is calibrated to a specific stream section using one or two observed flows, the corresponding water surface elevations, and cross sectional data at various locations in this stream section. The characteristics of the stream determine the number of cross sections needed to cover any given distance. The number needed will vary from stream to stream.

Field Data Requirements

Field data needed for input to the W.S.P. Program include the information previously mentioned plus a physical description of the stream section. Quality of this field data determines the accuracy of the computed results. These field data include:

1. Map showing stream section being studied and cross section locations,

2. Cross section survey data.

3. Distance between cross sections,

4. Measured flow in cubic feet per second,

5. Corresponding water surface elevations at all cross sections,

6. Photographs of the stream reach and cross sections,

7. Description of the stream bottom at each cross section (sand, gravel, cobbles, boulders, muck),

8. Description of bank and overbank material and vegetation (trees, brush, grass, logs)

9. Identification of points where streambed material, vegetation, and stream bank change within the cross sections.

If elevations are taken within ±.1 of a foot, the predicted water surface elevations will be within ±.1 foot. Figure 1&2 is an example of a stream section being studied. It also shows the location of cross sections. Figures 3 and 4 are plots of these cross sections.

Cross sections should be taken at right angles to the stream flow. Distance between cross sections should be measured along the line of flow or along thalweg (deep part of channel). Measurements should also be made at inside and outside of stream meanders. Critical sections or control sections should be included as a cross section. Where specific information in a transect is desired, for example, a spawning area, feeding area, or a resting area, be sure to include cross sections of that area.

In order for the output to be of more use to the individual performing the study, specific segments of the stream cross sections should be identified (see figures 3&4). This will enable the user to get specific information for that segment. At least one flow measurement should be made when taking the field data. This measurement must be identified with the water surface elevation at the time of measurement. The water surface elevations at the other cross sections should also be noted at the time flow measurements are being taken. It is useful to also observe High Water Marks (HWM) and tie them into the cross sections. This will give another set of elevations to firm up the field data and to help determine the proper energy slope of the specific stream reach being studied.

If log jams or debris dams are included in a study reach, cross sections should be taken above and below these areas. These areas will have some form of control for at least part of the study reach. When islands are included in a reach, cross sections should be taken upstream and downstream from the island and where the channels around the island begin and end (see example figure No. 2).

The most important point to make when taking field data is to be consistent. Cross sections should originate from the same side of the stream is possible. Left and right streambanks should be identified, whether looking upstream or downstream. Cross sections should be taken progressing in an upstream or downstream order.

In general, good surveying techniques should be used.

When field data collection is completed the individual cross sections should be plotted. The scale used is not particularly important. These plots should include identification of streambed material, types of vegetation on overbank, and identify left and right streambank.

Data Processing

After data is received it is readied for keypunching and running through the computer. An edit routine is used to check the keypunched data for errors. W.S.P. processes the data from the most downstream section through the most upstream section. Roughness coefficients are determined from the field data, observations, and photographs. An energy slope is determined from the streambed thalweg and observed water surface elevations. These observed water surface elevations must be tied to a specific streamflow as mentioned previously.

Calibration

The computer output for the observed flow is examined to determine if predicted water surface elevations match observed values. Adjustments in roughness coefficients ("n" values), cross sections, and station distances are made to bring predicted values within ±.2 feet of the observed values. After these adjustments have been made, a

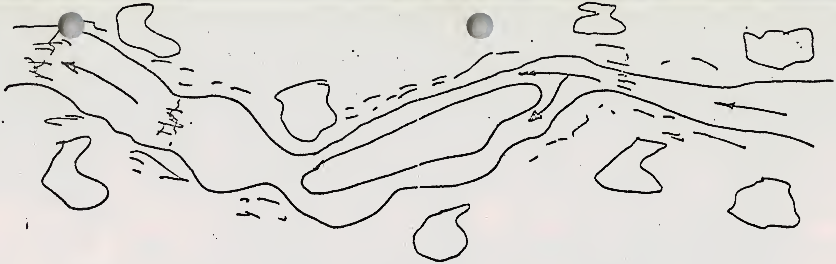
series of flows that include a probable low flow and a flood flow are set up (see figure or table). This set of flows is combined with the observed flow and cross-sectional data and run using W.S.P.

Available Output

Available output from W.S.P. includes specific data for each cross section and summary tables of data for all flows run. Specific cross section output includes water surface elevations, flow velocities in the cross sections, tractive force (amount of force exerted upon stream bottom), conveyance areas and widths, hydraulic radius, and discharges (see ~~figure~~ output sect. _____). Summary table information is available for water surface elevations, velocities, discharges, roughness coefficients, tractive forces, and main channel distances.

From the output data a water surface profile showing water surface elevations, streambed thalweg, and cross section location (by station) is plotted (figure No. 5). A rating curve for the most downstream section is also plotted (figure No. 6).

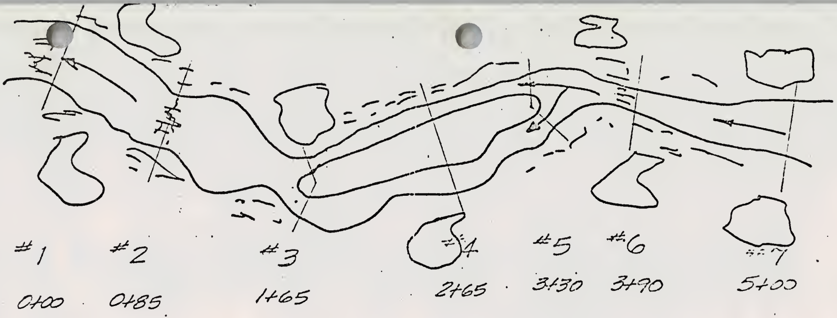
The cross-sectional data, computer output, water surface profiles, and rating curve are all returned to the investigator.
Use of this data will help determine stream maintenance flows and what effects higher or lower flows have on fish habitat. This data enables the user to predict changes in stream characteristics without having to make many field observations and measurements at different flows.



Deer Creek
near
Anywhere, Mont.

Typical Stream Section

Figure 1



Deer Creek
near
Anywhere, Mont.

Typical Stream Stretch
With Cross Section
Locations

Figure 2

K+E 10 X 10 TO ½ INCH 7 X 10 INCHES KEUFFEL & ESSER CO. MADE IN U.S.A. 46 1320

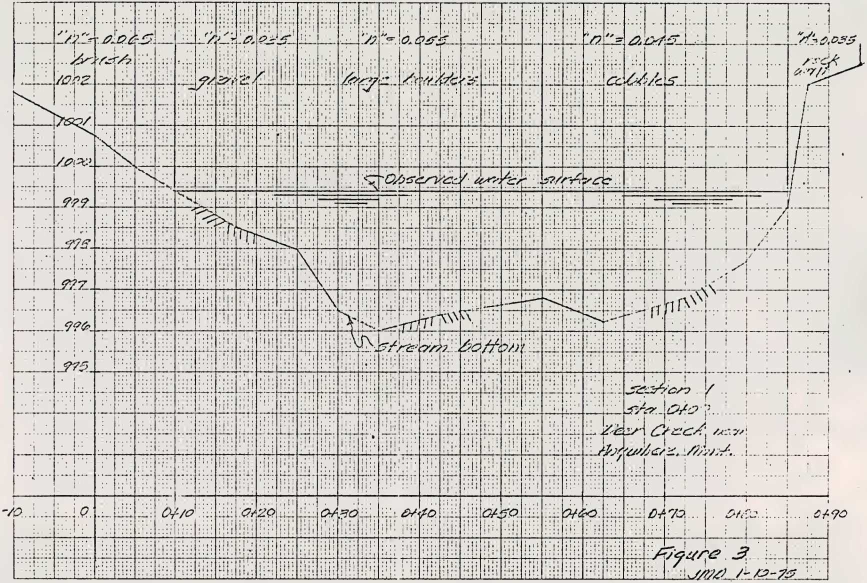
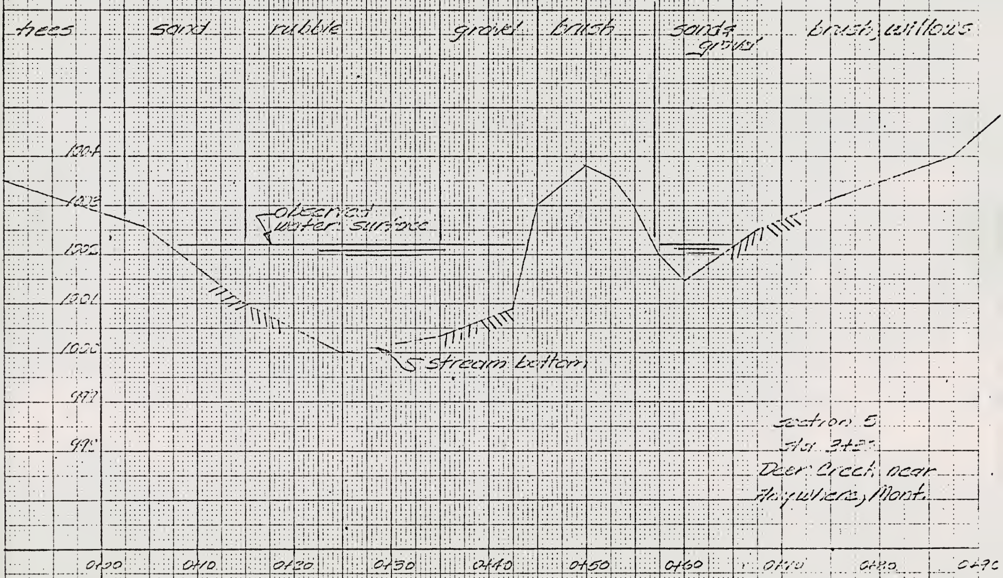


Figure 3

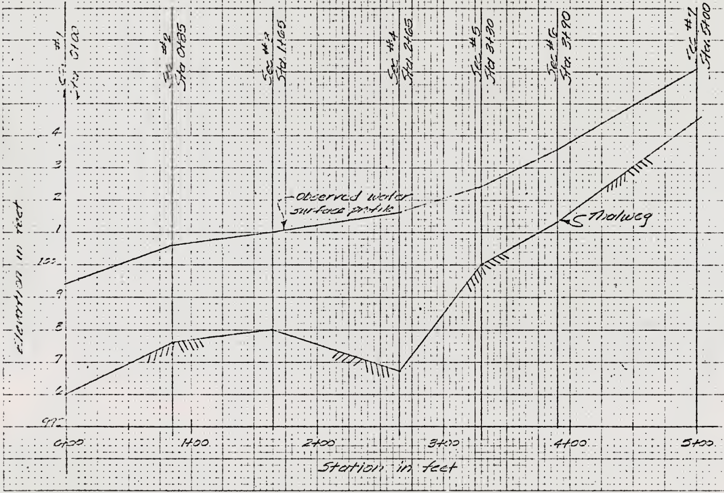
JMD 1-10-75

K+E 10 X 10 TO ½ INCH 7 X 10 INCHES KEUFFEL & ESSER CO. MADE IN U.S.A.
46 1320



section 5
Sta. 3+25
Deer Creek near
Anywhere, Mont.

Figure 4



Water Surface Profile

Deer Creek near
Anyrhsie, Montana

Figure 5

JMD 1-10-75

7-1654 (7-73)
Bureau of Reclamation

COMPUTATION SHEET

*U.S. Government Printing Office: 1973-784-219/1142 Region 8

BY [illegible]	DATE 1-75	PROJECT [illegible]	SHEET ____ OF ____
CHKD BY	DATE	FEATURE Bear Creek at [illegible]	
DETAILS Data for X-Sec #1			

Sta	B.S	H.I.	F.S.(B.S.) Grade Rod	Elev	Stream bottom	Habitat
X-Sec #1, Sta 0+00						
0-10	3.2			1001.8	clay	brush
0+00		1005.0	4.2	1000.8	sod	..
0+05			5.0	1000.0		
0+10		W.E. left	5.6	999.4	gravel	brush
0+18			6.5	998.5	gravel	
0+25			7.0	998.0	gravel	
0+30			8.5	996.5	large boulders	
0+35			9.0	996.0		
0+43			8.6	996.4		
0+55			8.2	996.8	large boulders	
0+62.5			8.7	996.3	cobbles	
0+72.5			8.2	996.8		
0+80			7.3	997.7		
0+85			6.0	999.0		
0+86		W.E. right	5.6	999.4	cobbles.	
0+88			3.0	1002.0	rock wall	
0+95			2.5	1002.5		
						brush

7-1654 (7-73)
Bureau of Reclamation

COMPUTATION SHEET

★U.S. Government Printing Office: 1973-784-219/1142 Region 8

BY	DATE	PROJECT / SHEET ___ OF ___
CHKD BY	DATE	FEATURE
DETAILS		

Sta	B.S.	H.I.	F.S.	Elev.	Remarks
0-10	3.5			1003.5	trees
0+00		1007.0	4.1	1002.9	
0+05			4.4	1002.6	sand
0+07		W.E. left	4.8	1002.2	
0+15			6.0	1001.0	sand
0+25			7.0	1000.0	rubble
0+35			6.65	1000.35	rubble
0+42			6.1	1000.9	gravel
0+44		W.E. right	4.8	1002.2	
0+45			4.0	1003.0	gravel brush
0+50			3.2	1003.8	(island)
0+57		W.E. left	4.7	1002.3	brush
0+60			5.5	1001.5	sand & gravel
0+65		W.E. right	4.7	1002.3	
0+68			4.4	1002.6	sand & gravel
0+83			3.0	1004.0	brush
1+00			1.5	1005.5	willows